I. Introduction

Terms of Reference

1. At a meeting of the Committee on Scientific Manpower in December, 1963, it was agreed that a study should be made of the needs of industry for the further development of postgraduate courses, of sessional or shorter duration, and of the relationship between postgraduate study and training in industry; together with related subjects, such as the movement of pure scientists into technology prior to and after entering industry.

Background to Enquiry

2. Since the Second World War there has been a gradual development of postgraduate courses of instruction of the longer type, usually of an academic session or a full year, and increasingly these have been recognised by universities for the award of a master's degree. These have been distinct from research courses for higher degrees, although instruction and research have not been entirely separated. The instructional courses have often contained a small research, development or design project, and increasingly research courses have had a series of lectures associated with them.

3. When the Committee on Scientific Manpower made its enquiry in 1955 into the recruitment of scientists and engineers by the engineering industry* it found that industry had considerable doubts about the value of both postgraduate research and postgraduate courses of instruction. At that time very few firms expressed a clear preference for men who had undertaken a postgraduate instructional course. Further consultations carried out in 1963† showed that most of those consulted considered that postgraduate studies were of great value for the best engineers, but only if undertaken after some years of experience in industry. There was still some feeling, however, that postgraduate work was of relatively little value for an industrial engineer.

4. In recent years many people in the academic world have expressed the belief that increased facilities for advanced technological training are needed and the Robbins Committee‡ in 1963 recommended the expansion of postgraduate courses of instruction in technology, recognising that some kinds of training might be more profitably taken after some years of experience. Courses of up to one year's duration for those with outside experience who wished to qualify in some new specialised field or new technique were considered to have already proved of great value and it was felt that there would be an increasing need for them.

5. More recently further interest has been stimulated in the extended use of postgraduate courses. Lord Todd, in the House of Lords in December, 1964§, expressed the view that greater attention should be paid to the

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* Report on the Recruitment of Scientists and Engineers by the Engineering Industry (H.M.S.O., 1955).

† Report by the Interdepartmental Committee on Improvement of the Status of Technology (January, 1964).

‡ Report on Higher Education (H.M.S.O., 1963), paras. 291, 294, 299.

§ Debate on Technology, House of Lords, 4th December, 1964.

scientific and technological training of those in industry; while a little later Lord Bowden*, then Minister of State for Education and Science, drew attention to the great need for periodic refresher courses for those engaged in industry. In a recent report† the Careers Research and Advisory Centre has advocated the need for an investigation into postgraduate courses of instruction.

Scope of Enquiry

6. Postgraduate courses as a whole form a wide band of activity. In order to confine this enquiry to manageable limits, it was decided that it would be restricted to full-time courses of at least one month in duration. Apart from such courses, there are a great number of part-time courses and courses of a few days' duration which are organised, mainly in colleges of technology, to meet the immediate and short-term needs of employers and others. These are widely supported by industry and the participation of educational institutions ranges from their organisation and provision of accommodation to full participation by teaching staff. Such courses are often self-supporting and, in any case, do not involve to the same extent the commitment of educational resources involved in the longer courses. The field of the short course could well be the subject of a separate investigation, but the main point to bear in mind here is that the scale of industrial support and participation is likely to be of quite a different order to that revealed in this report.

7. At one stage it was considered that the enquiry might refer to postgraduate courses for all those who might be described as technologists, but some difficulty was encountered in defining what was meant by a technologist. In view of the limited time available for the enquiry it was decided to confine the enquiry to courses in engineering and technology as defined in a list which had been used in the 1961 Census of Scientific and Technological Qualifications‡. This list was included in the notes sent out with the questionnaire to academic institutions (see Appendix 1, paragraph 3). Technology was here defined rather narrowly, but it brought the scope of the enquiry within manageable proportions for the time available.

8. The main interest was in the postgraduate courses offered by universities and the larger colleges of technology. It was appreciated that a number of courses of a postgraduate nature are organised by large industrial and scientific organisations, industrial research associations, consultants and independent colleges and organisations, especially for courses of a management nature, but in the time available it was considered best to concentrate the effort on courses organised by academic institutions.

Method Used

9. The first necessity was obviously to obtain detailed information about the postgraduate courses being run; information about the number and type of courses, the students attending, where the students came from and to what kind of work they were intending to proceed, and how they were financed. It would also be of interest to know how the courses were originated, the support

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* Annual Report of Manchester College of Science and Technology, 1963–64.

† C.R.A.C. Report on "Technology as a Career", 9th November, 1964.

‡ 1961 Census of Scientific and Technological Qualifications (H.M.S.O., 1962).

they were getting from industry, and any difficulties encountered in organising them. This was factual information which could be obtained by asking the academic institutions to complete a questionnaire. The first effort, therefore, was devoted to formulating a questionnaire to be sent to the relevant academic institutions which would supply the information needed. This is dealt with more fully in the next section.

10. When it came to considering the needs of industry and the relationship of postgraduate courses with training in industry, it was apparent that the use of a questionnaire would not be at all satisfactory. It needed exploratory discussions with representatives of industry and senior academic staff; discussions which would seek to clarify the issues involved and in which the views expressed by some could be checked with others. The second part of the enquiry, therefore, was a round of discussions with industrial representatives and academic staff, mainly professors, responsible for organising postgraduate courses. More is said about these discussions in sections IV and V.

Liaison

11. Steps were taken at the outset to have informal discussions with a number of bodies who were likely to be interested in this enquiry. These included the National Economic Development Office, the Department of Scientific and Industrial Research*, and the Office of the Committee of Vice-Chancellors and Principals of Universities.

II. Factual Enquiry

Formulation of Questionnaire

12. The questionnaire that was sent out to universities and colleges for completion is shown in Appendix I. It was felt that particular care was needed to define the scope of the enquiry and to indicate as clearly as possible the type of information required, and for this purpose guidance was provided by separate notes as well as on the questionnaire sheets themselves. The layout of the questionnaire and the accompanying notes were completed after the benefit of discussion with a few senior university staff. There were four parts to the questionnaire; parts I and II asked for particulars of the sessional and shorter courses respectively; part III asked for numbers of students attending for the current session and during the previous session; and part IV consisted of personal data sheets for completion by those students at present attending courses.

13. It was decided to send copies of the questionnaire direct to heads of departments of universities under cover of a letter from Sir Willis Jackson, Chairman of the Committee on Scientific Manpower, explaining the nature of the enquiry (see Appendix 2(*a*)) and to send a separate letter to Vice-Chancellors (Appendix 2(*b*)) explaining the action that had been taken and asking for their support. In the case of other academic institutions a single letter was sent to the Principals (Appendix 2(*c*)) together with supplies of the

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* This title is used throughout the Report though responsibilities for postgraduate awards passed to the Science Research Council when D.S.I.R. was dissolved in March 1965.

questionnaire. Helpful advice was obtained from the Office of the Committee of Vice-Chancellors and Principals of Universities regarding the university departments to approach, and from the Department of Education and Science regarding the technical colleges likely to be organising postgraduate courses. Questionnaires were eventually sent to 161 university departments, all the 10 Colleges of Advanced Technology* in England and Wales and one central institution in Scotland, the College of Aeronautics at Cranfield, 4 national colleges and 24 regional and area technical colleges.

14. Since the questionnaires were not going to be available until July it was decided to wait to send them out until the beginning of September and to ask for statistics in respect of the new session 1964–65 and the past session of 1963–64.

Response to Enquiry

15. Despite the many demands made on universities and colleges for statistical returns, the response to this enquiry was most encouraging. Many heads of departments who were not at present organising postgraduate courses took the trouble to send in their views of such courses and to indicate their plans for the future. It was felt important to try and obtain as complete information as possible, so the final analysis of the completed questionnaires was left until the middle of January, 1965, by which time a reply had been received from every department and college to which a questionnaire had been sent.

Analysis of Information

16. The analysis is presented in the next section, but at this point it is worth noting some of the difficulties that became apparent and the decisions made. These were:

(i) Some of the courses given in the completed questionnaires were borderline cases and individual decisions had to be made whether or not to include them. A few industrial administration courses were listed and, although these courses are attended by students of various other disciplines in addition to engineers, it was decided to include them in the survey. There was no way of telling what kind of jobs these students would be taking after their course of study. A few other courses dealt with techniques such as work study, operational research and ergonomics and these again are attended by students of different disciplines. Since many of those attending were engineers and others could well go into engineering or the defined technologies afterwards, these too were included in the survey. Some of the courses run in physics departments could be training physicists as well as some engineers for entry into the fields under investigation, so it was felt that all the students taking these courses should also be included. The total number of students included in this way was small compared to the number of straightforward cases.

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* This term is used throughout the Report though the Colleges are now proceeding to university status.

(ii) A particularly difficult decision to make was in the case of the Cambridge University Part II Tripos engineering students. These students had qualified for a degree at the end of their second year but were required to attend for a further year and were taking more advanced studies. Since it was doubtful whether these should be classified as postgraduate students, and quite a large number was involved, it was decided to omit them from the survey.

(iii) Some postgraduate courses were listed on the returns although no students were attending. It was known from discussions with some universities and colleges that where attempts had been made to start a course and had failed to attract any students then these had not been included in their completed questionnaires. The decision was taken, therefore, to exclude courses which were shown as having no students in both sessions 1963–64 and 1964–65.

(iv) Personal data sheets were requested for postgraduate students in attendance at the time the questionnaires were completed. In some cases the courses had not started (a few sessional courses started in January and a number of shorter courses started later in the session) although the numbers accepted were known and listed. In a few isolated instances all the personal data sheets could not be obtained from departments and colleges by the closing date for processing the statistics. There was no way of avoiding the discrepancy that would arise in the statistics whereby the analysis based on personal data sheets would have a total different to that shown as the total number of students attending postgraduate courses.

(v) There were certain difficulties in connection with the personal data sheets. For simplicity, 'country of origin' was used on the sheet to differentiate between United Kingdom and overseas students. It seemed desirable to try and distinguish between students of overseas origin who were now resident in this country and those who came simply for academic training, but no simple formula for doing this could be devised. In the event there seemed only a few students who might have been in the former category who would be shown in the statistics as overseas students along with all the others.

(vi) One return only indicated that students had experienced some difficulty in interpreting 'source of grant'. Checking by the sender had shown that one or two entries were incorrect and had had to be amended. There was no evidence of difficulty elsewhere, either from universities or colleges or from the personal data sheets themselves.

(vii) Part B of the personal data sheet sought to ascertain the future employment intentions of the students. Some students stated plainly that they had not made up their mind, but others indicated a multiple preference and, in the absence of amplifying remarks, these had to be interpreted as 'don't know'.

III. Factual Information

Number and Type of Postgraduate Courses

17. There are 264 separate postgraduate courses being run in 120 university or college departments, made up as shown in Tables 1 and 2. Of these 264 courses, 3 are of a predominantly management nature, 27 are conversion courses, and the remaining 234 are pursuing advanced studies.

Postgraduate Courses

Analysis by Length of Course

Table 1 Number

	Departments	Courses		
		Total	Sessional or longer	Shorter Courses
All Academic Institutions	120	264	218	46
Universities	75	168	148	20
Colleges of Advanced Technology(*a*)	23	47	34	13
National Colleges (*b*) ..	13	32	31	1
Regional Technical Colleges ..	9	17	5	12

(*a*) Including Central Institutions in Scotland.
(*b*) Including College of Aeronautics.

Analysis by Type of Course

Table 2 Number

	Total	Advanced Studies	Conversion Courses	Management
All Academic Institutions	264	234	27	3
Universities	168	152	14	2
Colleges of Advanced Technology	47	37	9	1
National Colleges	32	28	4	—
Regional Technical Colleges ..	17	17	—	—

18. Table 3 indicates how the courses are distributed amongst organising departments. It will be seen that only 46 courses out of 264 (17 per cent.) are shorter than a session, with 26 of these in colleges of technology. So far as the universities are concerned, the main emphasis is on postgraduate courses of a session's duration (148 out of 168) and of an advanced nature (152 out of 168). In the Colleges of Advanced Technology and regional technical colleges there is relatively a much greater provision of shorter courses. It must be remembered, of course, that information about shorter courses is available only for those starting early in the session. It must be remembered, also, that this survey relates only to full-time courses of at least a month in duration, and there are a very large number of shorter and part-time courses organised each session, mainly by technical colleges.

Postgraduate Courses

Analysis by Organising Department

Table 3

Number

	All Departments	Engineering and Technology Departments(a)									Science Departments	Administration Departments
		Aeronautical	Chemical	Civil	Electrical	Mechanical	Metallurgy	Mining	Production	Other		
Total	264	15	26	36	50	57	6	9	13	23	26	3
Sessional or Longer Courses:												
Total	218	14	26	35	42	36	6	6	11	19	20	3
Universities	148	2	16	31	30	30	5	6	5	9	12	2
Colleges of Advanced Technology	34	1	10	3	6	2	—	—	2	1	8	1
National Colleges	31	11	—	—	6	1	—	—	4	9	—	—
Regional Technical Colleges ..	5	—	—	1	—	3	1	—	—	—	—	—
Shorter Courses:												
Total	46	1	—	1	8	21	—	3	2	4	6	—
Universities	20	—	—	1	5	10	—	3	—	1	—	—
Colleges of Advanced Technology	13	1	—	—	—	6	—	—	1	1	4	—
National Colleges	1	—	—	—	—	—	—	—	—	1	—	—
Regional Technical Colleges ..	12	—	—	—	3	5	—	—	1	1	2	—

(a) Some condensation of departmental titles has been effected for the sake of conciseness.

19. The majority of courses are organised in departments of chemical, civil, electrical/electronic and mechanical engineering. Of the other departments, those of aeronautical engineering, production engineering and physics (electronics, solid-state physics, nuclear physics and acoustics) make most contribution.

20. From the replies received from heads of departments of universities who do not at present offer postgraduate courses, it is evident that many departments are hoping to organise such courses within the next few years.

21. A full list of the postgraduate courses that are actually being run is given in Appendix 7.

Number of Students

22. The numbers of postgraduate students attending different types of academic institutions are given in Table 4, and a break-down between United Kingdom and overseas students for session 1964–65 is given in Table 5. As pointed out in paragraph 18 above, the figures for the current session in Table 4 relate only to courses starting the early part of the session. Some shorter courses may have been run later in the session and the number of students who might have attended these was not known.

Students attending Postgraduate Courses

All Students

1963/64 and 1964/65

Table 4

Number

	1963/64			1964/65		
	Total	Sessional or longer	Shorter Courses	Total	Sessional or longer	Shorter Courses
All Academic Institutions	1,668	1,311	357	1,966	1,642	324
Universities	1,067	864	203	1,188	1,068	120
Colleges of Advanced Technology	267	162	105	336	244	92
National Colleges	288	267	21	330	306	24
Regional Technical Colleges	46	18	28	112	24	88

23. It will be seen from Table 4 that the number of students for the current session is already greater than for the previous session. Many of the short courses this season had not started and the number of students who would be attending was not known, so the probability is that the final total for 1964–65 will be substantially greater than for 1963–64. The main reason is that a good number of new courses have been started. Almost three-fifths of the post graduate students are attending courses in universities.

24. In the current session 1,966 students are distributed over 264 courses, which gives an average of approximately 7 students per course. Some courses are considerably larger than this, and 99 courses actually have 4 or fewer students in them.

25. Table 5 shows that:

(i) a little less than half (45 per cent.) of all the postgraduate students in this country on these types of courses are from overseas ; and

(ii) there is the largest proportion (60 per cent.) of overseas students in the colleges of advanced technology.

Students attending Postgraduate Courses

United Kingdom and Overseas Students

1964/65

Table 5

	All Students	United Kingdom Students	Overseas Students	
	Number	Number	Number	Percentage
Total (from Table 4)	1,966	—	—	—
Total for whom information was available (*a*)	1,633	902	731	45
Sessional Courses ar Longer:				
Total	1,539	829	710	46
Universities	1,000	524	476	48
Colleges of Advanced Technology ..	241	96	145	60
National Colleges	274	199	75	27
Regional Technical Colleges	24	10	14	58
Shorter Courses:				
Total	94	73	21	23
Universities	39	31	8	21
Colleges of Advanced Technology ..	9	6	3	33
National Colleges	24	16	8	33
Regional Technical Colleges	22	20	2	9

(*a*) Personal data sheets were not available for those students whose courses had not started at the time information was obtained, although the total number of students due to attend was known.

26. It is worth mentioning that a number of heads of departments of universities have expressed the view that while employers are reluctant to release staff for long postgraduate courses (a matter touched on in the next paragraph and dealt with more fully in section V), and there is so much pressure for admission from overseas students, they do not wish to embark on organising postgraduate courses.

27. It is interesting to compare the numbers of students in the final year of first degree and other courses in engineering and technology with those taking postgraduate courses of instruction and those doing research work for higher degrees. These are given in Table 6 and, of course, relate only to engineering and technological courses (see paragraph 7).

Engineering and Technology

Comparison of Types of Students

Table 6 Number

Type of Student	1962/63	1963/64	1964/65
Postgraduate Instructional Course	n.a.	1,668	1,966
Research	n.a.	1,838	2,723
Final Year of First Degree Course	2,881	3,381	n.a.
Diploma in Technology Course	1,250	1,200	n.a.
Higher National Diploma Course	1,331	1,657	n.a.
Higher National Certificate Course	17,462	18,261	n.a.

n.a.—not available.

28. The numbers of students taking postgraduate instructional courses in the main disciplines are shown in Table 7.

Students Attending Postgraduate Courses

Analysis by Type of Course

Table 7 Number

Type of Engineering or Technology	1963/64	1964/65
All Types	1,668	1,966
Aeronautical Engineering	168	178
Chemical Engineering	133	166
Civil Engineering	300	345
Electrical Engineering	256	306
Mechanical Engineering	384	389
Metallurgy	21	36
Mining Engineering	36	44
Production Engineering	123	143
Others	247	359

29. It will be seen that the current session shows an increase in the number of students over last session in every single case.

30. The opportunity was taken to look at the number of students with science and other qualifications who are taking postgraduate courses fitting them to take work in engineering and technological fields. The number of such students is shown in the analysis in Table 8. This information needs to be treated with caution, however, since courses such as industrial administration and operational research may lead to work concerned with engineering and the types of technology being considered or to work in other fields. The same applies to some of the physics courses. Nevertheless, a total of 403 out of 1,633 students (25 per cent.) is a substantial one, and the majority are to be found on special technological courses such as rubber, plastics, textiles and brewing.

Students attending Postgraduate Courses

Analysis by Subject of First Qualification

1964/65

Table 8

Number

	All Students	United Kingdom Students			Overseas Students		
		Total	Straight from First Degree	Gap since First Degree	Total	Straight from First Degree	Gap since First Degree
All Qualifications ..	1,633	902	367 (*a*)	530 (*a*)	731	165 (*a*)	561 (*a*)
In Engineering ..	1,230	698	268 (*a*)	425 (*a*)	532	130 (*a*)	397 (*a*)
In Science:							
Total	361	180	85	95	181	33	148
Chemistry ..	89	43	26	17	46	4	42
Geology ..	23	7	2	5	16	4	12
Mathematics ..	37	24	14	10	13	2	11
Physics	103	74	32	42	29	7	22
General Science	109	32	11	21	77	16	61
In Arts and Other Subjects	42	24	14	10	18	2	16

(*a*) Information was not available for 5 U.K. Students and 5 Overseas Students.

31. The opportunity was also taken to look at the numbers of postgraduate course students in the current session according to the type of first qualification they possessed. This analysis is given in Table 9.

32. The analysis in Table 9 indicates that:

(i) The percentage of those with a degree attending courses at universities and Colleges of Advanced Technology (79 per cent. and 72 per cent. respectively) is appreciably higher than at national colleges or regional technical colleges (46 per cent. in each case).

(ii) If diplomas in technology are included with degrees, the same trend is apparent (the percentages being 83 per cent., 80 per cent. and 50 per cent. respectively).

(iii) An appreciable number of those who enter postgraduate courses have qualifications gained through part-time study, i.e., a Higher National Certificate or graduateship of a professional institution (13 per cent.), and the majority of these are to be found in the national colleges (26 per cent.) and in the universities (8 per cent.).

(iv) The great majority of overseas students have a degree (86 per cent.).

Financing of Students

33. Students attending courses were invited to provide information about how they were being financed to attend these courses, and this information for United Kingdom students is summarised in Table 10. The number of such students sponsored by employers is of especial interest, and is analysed separately in Table 11.

Students attending postgraduate courses

Analysis by type of first qualification

1964/65

Table 9

Number

	Total	Degree	Diploma in Technology	College Diploma	Higher National Diploma	Higher National Certificate	Graduate of Professional Institution
Students at all institutions							
Total	1,623(*a*)	1,152	78	119	70	129	75
U.K. students:							
Straight from first qualification	367	236	34	24	32	27	14
With gap since first qualification	530	295	37	39	30	91	38
Overseas students	726	621	7	56	8	11	23
At Universities							
Total	1,029(*a*)	816	41	65	20	47	40
U.K. students:							
Straight from first qualification	242	201	13	14	6	3	5
With gap since first qualification	308	199	24	11	9	39	26
Overseas students	479	416	4	40	5	5	9
At Colleges of Advanced Technology							
Total	250	179	22	11	3	12	23
U.K. students:							
Straight from first qualification	42	18	16	—	—	4	4
With gap since first qualification	60	38	4	2	3	4	9
Overseas students	148	123	2	9	—	4	10
At National Colleges							
Total	298	136	13	41	32	65	11
U.K. students:							
Straight from first qualification	61	11	3	10	12	20	5
With gap since first qualification	154	55	9	26	18	43	3
Overseas students	83	70	1	5	2	2	3
At Regional Technical Colleges							
Total	46	21	2	2	15	5	1
U.K. students:							
Straight from first qualification	22	6	2	—	14	—	—
With gap since first qualification	8	3	—	—	—	5	—
Overseas students	16	12	—	2	1	—	1

(*a*) These totals are 10 less than sbown in Table 5 since personal data sheets were not available for 5 U.K. students and 5 overseas students (see footnote to Table 8).

United Kingdom Students

Analysis by Type of Financial Assistance

1964/65

Table 10

Number

	Total	Straight from First Degree				Gap since First Degree			
		Universities	C.A.T.S.	National Colleges	Regional Colleges	Universities	C.A.T.S.	National Colleges	Regional Colleges
All Students	902	—	—	—	—	—	—	—	—
Information Obtained: ..	897	242	42	61	22	308	60	154	8
D.S.I.R. Award ..	274	156	14	2	1	87	10	3	1
L.E.A. Award ..	121	33	9	15	8	30	7	19	—
Scholarship	163	22	3	27	—	45	4	61	1
Employer	207	15	3	14	6	93	8	62	6
None	132	16	13	3	7	53	31	9	—
No Information ..	5	—	—	—	—	—	—	—	—

United Kingdom Students

Analysis of Students Financed by Employers

1964/65

Table 11

	Total		Straight from First Degree		Gap Since First Degree	
	Number	Per cent. of total	Number	Per cent. of total	Number	Per cent. of total
All Institutions	207	23	38	10	169	32
Universities..	108	20	15	6	93	30
Colleges of Advanced Technology	11	11	3	7	8	13
National Colleges	76	35	14	23	62	40
Regional Technical Colleges	12	40	6	27	6	75

34. The main points to be drawn from these tables are:

(i) 367 out of a total of 897 students (41 per cent.) went straight from a first degree course or equivalent to a postgraduate course. Almost half (47 per cent.) are financed through D.S.I.R. grants, a number (18 per cent.) are financed through grants from their Local Education Authorities, and a smaller number (10 per cent.) are sponsored by their employers. Of those financed by employers, 38 all told, the majority had been sponsored by their firms to take their first degree course and so were quite well known to them. This information was not asked for specifically in the questionnaire and so the precise number of such students is not known. At least a few postgraduate students, however, are sponsored by firms after having just been recruited by them.

(ii) 530 out of the 897 students (59 per cent.) had had at least a year's experience in industry or some kind of work before taking a postgraduate course. Those sponsored by their employers constitute the largest proportion, but this is only a total of 169 and represents 32 per cent. of such students. 101 (19 per cent.) have D.S.I.R. grants and a further 56 (11 per cent.) have grants from their Local Education Authorities. 111 students (21 per cent.) are aided by some form of scholarship, the majority of these being from funds at the disposal of the university or college. Approximately one-sixth of these students are not being financed in any way, and have given up their employment in order to try and better themselves or find a different kind of job.

(iii) The total number of students being sponsored by their employers is 207. The survey covers 264 courses, so this means that on average less than one student per course is sponsored by employers. A greater proportion of students is sponsored by employers at National Colleges and Regional Technical Colleges, which perhaps indicates the greater liaison existing between these colleges and industry for this type of course. In the Regional Technical Colleges the courses concerned are mainly the shorter ones (see paragraph 2).

35. The ways in which overseas students are being financed are given in Table 12. These figures indicate that :

(i) Just over half the overseas students (52 per cent.) are paying their own way.

Overseas Students

Analysis by Type of Financial Assistance

1964/65

Table 12

Number

	Total	Straight from First Degree					Gap since First Degree				
		Total	Univer-sities	C.A.T.S.	National Colleges	Regional Colleges	Total	Univer-sities	C.A.T.S.	National Colleges	Regional Colleges
All Students ..	731	—	—	—	—	—	—	—	—	—	—
Information obtained:	726	165	121	30	10	4	561	358	118	73	12
D.S.I.R. awards ..	5	2	2	—	—	—	3	3	—	—	—
L.E.A. awards ..	7	4	2	1	1	—	3	2	1	—	—
Scholarships ..	209	48	43	—	4	1	161	129	8	17	7
Government ..	60	13	12	—	1	—	47	32	3	11	1
Employer ..	67	7	5	1	1	—	60	40	11	9	—
None	378	91	57	28	3	3	287	152	95	36	4
No information ..	5	—	—	—	—	—	—	—	—	—	—

(ii) 209 out of 726 students (29 per cent.) are in receipt of some form of scholarship or award (those quoted chiefly are Athlone, Colombo Plan, Commonwealth and British Council awards, while a number are made by international organisations and from university and college funds);

(iii) 67 out of 726 students (9 per cent.) are sponsored by their employers to attend courses in this country.

36. It is interesting to note that the number of overseas students sponsored by employers is one-third the number of students from the whole of this country to be sponsored by employers (67 compared to 207).

Future Employment of Students

37. Students were asked to indicate the type of work to which they intended proceeding after finishing their postgraduate course of study. The broad categories given were those of research, teaching, industry, industrial research associations, government departments and consultancy. Students were also asked to indicate whether they were intending to work in this country or seek employment abroad. The information supplied is summarised in Table 13.

38. The figures indicate that:

(i) The greatest proportion of United Kingdom students is that wishing to go into employment in the fields of research, development and design. The next largest proportion wishes to go into production work, and almost as many wish to continue at universities in this country doing research for a higher degree. Comparing those who have had employment before taking their postgraduate course with those coming straight from their first degree course, the only large variation is that more wish to go into teaching and fewer to pursue research for a higher degree.

(ii) In the case of overseas students the great majority wish either to remain in this country to pursue research for a higher degree or to find employment overseas—mainly in their own countries. It is doubtful how many of these students will be able to carry on with research work at universities or colleges in this country. A number of students indicated that they hope to remain in this country on completion of their course, at least for a while, in order to gain experience of applying the principles, methods and techniques met with on their postgraduate course of study.

Initiation of Courses

39. The great majority of postgraduate courses have been started on the initiative of universities and colleges. Only in a few isolated cases have courses been shown as springing from an approach by a firm or organisation. Some courses initiated by academic institutions have been shaped in part as a result of discussions with employers, and others have been gradually adapted to meet suggestions made by employers sponsoring students to attend. In the main, however, it is clear that most of the initiative for developing posgraduate courses has rested with academic staff.

Future Employment of Students

1964/65

Table 13 Number

	United Kingdom Students			Overseas Students		
	Total	Straight from First Degree	Gap since First Degree	Total	Straight from First Degree	Gap since First Degree
All Students	902	—	—	731	—	—
Information Obtained	803	289	514	640	144	496
In United Kingdom:						
Total	757	274	483	358	84	274
Research for Higher Degree	105	71	34	227	55	172
Teaching	45	7	38	2	—	2
Employment:						
Total	607	196	411	129	29	100
Government Departments	56	18	38	5	2	3
Industrial Research Associations	6	2	4	—	—	—
Research, Development and Design	336	101	235	50	17	33
Production and Management	125	52	73	37	5	32
Consultants	57	18	39	28	2	26
Miscellaneous	27	5	22	9	3	6
Overseas:						
Total	46	15	31	282	60	222
Research for Higher Degree	8	—	8	17	9	8
Teaching	5	1	4	34	8	26
Employment	33	14	19	231	43	188
Don't Know	94	70	24	86	21	65
No Information	5	—	—	5	—	—

Support of Employers

40. The most common entry under this heading of the questionnaire was to the effect that employers gave little support and displayed little interest. Often there was the additional comment that while they would not send students employers were very willing to recruit the students from the postgraduate courses. There were exceptions to this general trend when it was reported that good support was forthcoming from employers, and often these were courses where the initiative to start them had come from industry or where the courses had been developed in close consultation with particular firms or a particular industry.

41. In addition to lack of interest from industry, mention was made of other difficulties. Most frequently these were criticisms of the number and amount of D.S.I.R. awards and their effect in limiting the number of postgraduate students. Occasional mention was made of lack of staff and lack of accommodation for developing postgraduate courses.

42. Only occasional use seems to be made of lecturers from industry, industrial research centres or government departments, and these are usually designated as part-time, occasional or special lecturers. No suggestion was made that any difficulty was encountered in obtaining help of this kind.

IV. Discussions with Industrial Representatives

Scope of Discussions

43. It had been decided at the outset that discussions with industrial representatives would be needed (see paragraph 10). A great deal of time was not available for these discussions, so it was obvious that an ad hoc selection of industrial firms and organisations to be visited would have to be made. The selection made is given in Appendix 3, and the choice was determined mainly by the interest in training that was known to exist in these companies. It was determined to some extent also by personal contacts in the companies and the desire to cover the main branches of engineering. A letter was first sent to the Chairmen of the companies concerned (Appendix 4) and arrangements were then made for the visit with the person indicated in the reply. The number of senior staff seen on each visit varied, but altogether discussions were held with 51 industrial representatives. A few chairmen were seen, but in the main the discussions were with senior engineering, research, development, technical, production, personnel and training staff, frequently at director level.

Information Obtained

44. The discussions were of an informal kind and ranged widely over the whole field of training, but a certain minimum ground was covered each time as indicated in Appendix 5. This was a proforma used for recording the information obtained from each visit. On some visits the representatives were seen separately, while on others there was the opportunity for a round-table discussion. The latter method seemed preferable, because it provided cross-discussion and helped the emergence of a consensus of opinion or showed up clearly fundamental differences in views.

45. Although everyone seen was most interested in the enquiry and was helpful and anxious to provide as much information as possible, these discussions had their limitations. In the case of large organisations the staff at the headquarters were able to give qualitative assessments of the position but, understandably, were not in touch with the detailed training position in the constituent units. Whilst in some cases precise detailed information had been obtained, or was to some extent obtained subsequently, in others it would have been imposing on the co-operation shown to request that quite major surveys should be mounted to obtain such information. Some of the topics discussed involved matters of opinion, and in many cases the staff concerned were at pains to emphasise that they could not express an official company view but could only provide their own personal opinion. It was a matter of judgment as to what weight should be given to the various personal opinions so expressed. This was where the round-table discussion had a decided advantage.

46. Since discussions were also held with senior academic staff on the same points (section V), and the object of the enquiry was to try and draw conclusions from the weight of evidence so provided, the information obtained from industrial staff is not detailed separately but is merged with that obtained from academic staff and presented in secton VI.

Effects of Enquiry

47. The very fact of approaching these industrial organisations and having discussions with senior members of staff had some effects. In many cases it was obvious that the matters under consideration had been given some careful thought before the visit, and the discussions themselves provoked further thought and perhaps raised fresh points for more consideration later. Although these effects should not be over-rated, some industrial representatives did say that now postgraduate courses had received closer attention in their organisation there might well be further use made of them in the future.

V. Discussions with Academic Staff

Scope of Discussions

48. It was felt that discussions with academic staff were needed to complement the views obtained from industrial representatives and to discuss in more detail than the questionnaire allowed problems associated with the organising of postgraduate courses. To make best use of the time available, those universities and colleges were visited which were offering the bulk of the postgraduate courses, and in each case as many engineering and technological departments as possible were consulted. In some cases principals, vice-principals and academic registrars were seen, but very largely it was the heads of departments or, in their absence, members of their staff whose views were obtained. The list of universities and colleges visited is given in Appendix 6. Altogether, 79 senior academic staff were seen in the 20 institutions visited.

Information Obtained

49. As in the case of industrial representatives the discussions were on an informal basis, but care was taken to obtain the views of academic staff on the main points arising from the talks with industry. New points brought up by academic staff, especially in connection with the difficulties encountered in running postgraduate courses, were checked with those seen later, so that there was a gradual cumulative effect which tended to make the later discussions more extensive. In some cases arrangements had been made for a round-table discussion with a number of heads of departments, and as in the case of the industrial visits this method was found more helpful and certainly less time-consuming.

50. A most encouraging feature was the helpfulness and co-operation experienced on these visits and the interest displayed generally in the enquiry. Views were expressed frankly and, as might be expected in the absence of anything akin to a " company policy " or " company view ", tended to be more divergent than with industrial representatives. However common strands were discernible, and it is these that are set down in Section VI and interwoven with the views of industry in some form of logical pattern.

51. It is important to record here a point of view which was expressed in several universities ; that the postgraduate courses need not, and perhaps in many cases ought not, to be directed at meeting short-term industrial requirements. The opinion was strongly voiced that the basic obligation was to

establish a broad intellectual foundation which would assist the students in the identification and solution of problems associated with their subsequent employment. This point is brought out later in paragraphs 68–70 and needs to be remembered against the general criticism levelled against postgraduate courses for not meeting the specific short-term needs of industry. The point was also made strongly that employers had not been particularly effective in defining their requirements, and it was hoped that this enquiry would stimulate industry to make a much clearer statement in this respect and to seek a closer partnership with the universities in the consideration of how best to fulfil a joint responsibility. Paragraph 80 refers to this point.

Effects of Enquiry

52. As in the case of the industrial visits, there was the impression that the discussions with academic staff had some effects in themselves, however slight. The questionnaire was undoubtedly just an added burden to administratively overloaded departments, but the discussions possibly produced a certain amount of re-thinking of the way in which postgraduate courses were conducted, especially in the light of the indications which could be given of the broad views expressed by industrial representatives. All the academic institutions visited were very much in the throes of expansion and varying degrees of reorganisation, and while this was perhaps an opportune time to consider the purpose and nature of postgraduate instructional courses there were many other matters competing for attention.

VI. Views Emerging from Discussions

General Considerations

53. One of the main purposes of this report was to establish and record the views of senior industrialists and academic staff on the present situation concerning postgraduate courses. It has not been the author's intent to do more than this, and he has not felt justified in passing judgments on these views or developing recommendations for policy out of them. The views expressed by senior industrialists and academic staff have varied greatly, and one of the main tasks in this enquiry has been to sift all these views and present them in some kind of coherent and logical pattern. Care has been taken to ensure that all views with at least a fair measure of support have been included. Discretion has had to be exercised to the extent that isolated views running contrary to the weight of opinion have not been included unless they seemed of especial significance. It must be emphasised, however, that the views recorded are the views of those with whom the author discussed the problem and are not necessarily his own.

54. The present situation, of course, is that on the whole few students on the type of postgraduate course under review are sponsored by industry. By this is meant industry actively seeking to send staff to these postgraduate courses and ensuring that they are not worse off financially during their attendance. If industry feel that it is a good investment to send a member of staff to a postgraduate course they would not, in general, have any hesitation in sponsoring him in this way. The present lack of support by industry, therefore, is an indication that only to a very limited extent does it

feel that the existing courses are meeting a real or urgent need. Full sponsorship is normally reserved for staff who have had a few years' experience with the company and who are highly valued by it. In other cases where the initiative to go comes largely from the man, leave of absence is often granted. This is industry's general view, whether misguided or not, and in the following paragraphs the underlying factors are examined more closely.

55. It is impossible to get very far discussing industrial staff generally or postgraduate courses generally, since the possible training needs of staff depend upon the nature of the work they are performing and postgraduate courses may take quite different forms. Broad categories may be distinguished as follows:

(*a*) Industrial staff:

- (i) staff engaged on production work, to whom management is the prime concern ;
- (ii) staff engaged on research, development, technical and design work, to whom the application of scientific and technological information is important in addition to possible aspects of management.

(*b*) Postgraduate courses:

- (i) those with a management character, dealing with general management development, management skills and especially efficiency techniques ;
- (ii) those giving more advanced knowledge, but covering a relatively wide range and in effect dealing with material which lack of time prevents from inclusion in a first degree or equivalent course ;
- (iii) those seeking to go close to the frontiers of knowledge in a much more restricted field ;
- (iv) those of a conversion nature, seeking to give knowledge to a graduate of one discipline so that he can undertake work in another discipline or special technology.

Production Staff

56. Industry in general feel there is no real need for production staff to have long courses giving advanced technological information unless they are being prepared for transfer to other kinds of work. It is advantageous for them to keep abreast of main developments in their own discipline and especially in connection with their plant or factory processes, but this can be done by reading, by attendance at professional institution meetings, and by attendance at short courses, conferences or symposia. The last mentioned may be evening, part-time day, or full-time lasting anything from one to five days. A lot of such courses, conferences and symposia are arranged either by or with the help of universities or technical colleges, especially by the latter, and also by professional institutions and other bodies, and are well supported by industry.

57. Industry is recognising more and more the need for these staff to have training in efficiency techniques and general management. A lot of management training is carried out internally by the larger companies and industrial organisations, but such internal training is usually supplemented

by the use of intensive courses run by a variety of bodies, including universities and colleges. Other companies rely entirely on the external courses. Despite the great deal of scepticism that still exists about the value of formal management training, it is interesting to note from the information obtained from industry that more industrial staff of all kinds are sent on the longer type of management course than on the longer courses of an advanced technological character. Senior management take a hard-headed approach to the use of postgraduate courses and will only agree to send staff if they feel reasonably satisfied about the economic value of any particular course to the work of their organisation. The value of a course needs to be clearly explained or demonstrated if industrial support is to be expected, and this applies in particular to efficiency techniques. Once reasonably satisfied about the economic value of an efficiency technique, companies will send both specialist efficiency services staff and general management to appropriate courses. There appears to be no great difficulty in releasing specialist staff to undertake quite long courses, and existing courses seem adequate to meet the demand. In the case of other management staff, however, there is the great problem of release from normal duty, and this is discussed further in the next paragraph.

58. Only the very exceptional company carries additional staff to enable training to be carried out on a regular basis. Consequently most companies and organisations find themselves faced with having to cover a man's job if he is to be released for a training course. Production work must go on, and in general this means that companies are reluctant to release staff for more than a few days. Only the larger organisations are able without much difficulty to make arrangements to cover an absence for a longer period, and many of these are willing to release a small number of staff for periods up to three months. Occasionally men will be released for longer periods, but these are very much the exception and are usually special cases. For the member of staff selection for a longer course is usually a sign that his ability is being recognised and he is willing to make the sacrifice of disruption of normal family life, but there is some resistance to courses of longer duration than three months from the older man. Not only is there family hardship, but if an absence is for more than three months a man may well feel he is getting out of touch with events in the company and is even missing chances of promotion. The pressure is, therefore, all for the shorter courses of management training or for training on a thin sandwich basis, and especially for the very short courses and conferences on efficiency techniques, particularly those that are able to give information on where these techniques have been applied and with what experience and results.

59. Immediate long postgraduate courses in management training are not supported by industry, since it is believed that the training is more beneficial after some experience of the problems of management and also because a firm wants to get a feel for a man's potential before sending him on an expensive course. To some extent there is also the feeling that it may not be wise to invest in a very young man who may soon leave, especially if the course leads to a recognised qualification. Many firms have lost young men after sending them on courses and so increased their market value, and there is a growing appreciation of the need to link intensive training with proper plans for making full use of a man's abilities afterwards. While industry

would not in general sponsor a graduate recruit to undertake immediately a long postgraduate management course, they might well be interested in recruiting a man after he had completed such a course of training.

Research, Development, Technical and Design Staff

60. Where general management and efficiency techniques apply to research, development, technical and design departments, and this is often regarded as being to a much more limited extent than in production departments, then the comments in paragraphs 52 and 53 above apply. Although the release problem is perhaps not quite so acute in the case of research and development staff, since work programmes are more capable of some adjustment in these departments, it is still difficult and there is often more scepticism of the relevance of management training to their work.

61. One would expect that it would be these categories of staff who would need postgraduate courses giving advanced information, yet the numbers sponsored by industry to take the longer courses is still small—smaller than in the case of management courses. Reasons advanced for this state of affairs are of especial interest and are looked at more closely in the following paragraphs.

62. The big organisations usually have their own large and well-equipped research and development laboratories and claim that along their particular lines of interest they have gone further and deeper than most universities or colleges. They feel, therefore, that they can impart more expertise to the new graduate by putting him to work in their own laboratories than by sending him to a postgraduate course at an academic institution. The same philosophy applies to staff in technical and design departments working on particular types of plant and products. There appears to be a tendency for industry to organise itself into larger units, and so for this state of affairs to become more widespread. If a man requires specialist training, some part of the organisation can provide it. There are dangers in too great a reliance on internal training : not enough new ideas may be getting into the organisation ; if expertise does exist it may not be presented adequately to the newcomer ; and training on the job tends to be of a very narrow kind. To be fair to industry, however, it should be said that it very much encourages its scientific and technological staff to keep up-to-date by reading journals, attending meetings of professional institutions, and attending short courses, conferences and symposia organised both by academic and industrial organisations. There is doubt expressed by some academic staff about the extent to which deep knowledge and real expertise exists in industrial organisations, even the large ones, but such sweeping generalisation is not generally supported. The majority view is that the science-based industries are well in the van of progress, but that the same position may not apply to other industries or to many smaller firms (this corresponds broadly to the views expressed in the Annual Report of the Advisory Council on Scientific Policy, 1963–1964*.) On the other hand many postgraduate courses offered by academic institutions are criticised by industry as being merely extensions of the first degree course and having little relevance to the needs of the firms. A large amount of information is given, but with little or no reference to its applications in industry. The views so expressed, particularly the extreme ones, are

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* Annual Report of the Advisory Council on Scientific Policy, 1963–1964, Cmnd. 2538, December, 1964, paras. 33, 39.

indicative of a gulf that exists between many university departments and industry. Some university engineering departments see their main function as the furtherance of fundamental knowledge, a role not easily reconciled with industrial requirements, and equally sections of industry show an academic antipathy and have not seriously considered how universities and colleges might be of assistance to them in training staff through postgraduate courses. This gulf that exists certainly seems one reason why so many postgraduate courses are offered and yet so few students are sent by industry. This mutual suspicion may stem partly from the traditional reluctance of universities to admit technology as an academic subject, since it does not seem to apply in the case of technical colleges with their traditional closer links with industry or to colleges set up to serve specific industries.

63. There are some notable exceptions to the state of affairs outlined above. Some university departments make great efforts to bridge this gulf and seek to establish close contacts with particular firms and organisations and particularly with industrial and government research centres. They try to diagnose the needs of sections of industry and are in a position to mount helpful postgraduate courses, sometimes with the assistance of staff from research centres and from industry. They usually find it difficult to get the first few students from industry, but when the course is found useful the numbers rise in successive years. There are also cases where a particular company or section of industry has approached a university with a request to mount a particular kind of postgraduate course. Occasionally a fund has been placed at the disposal of the head of department to award bursaries for the course. Such courses are well supported by industry in the initial years, although in time the need for the particular kind of training is liable to disappear. This illustrates, however, how successful postgraduate courses can be mounted if positive steps are taken by university departments and industry to establish contacts with the other.

64. Industry is especially critical of the attempts of universities to give design training and quotes the Feilden Report* in support of this view. It is felt that many of the projects given are of an academic nature and are not dealt with in a full industrial context. However, at least one well-supported design course has been produced, a two-year course arranged specifically for the aircraft industry, and some universities and colleges have proposed setting up new schools of engineering design, working in close co-operation with industry to train engineers to deal with the practical and design problems encountered in the factories. This seems a further encouraging sign of the fruitful collaboration that can take place.

65. Some companies do not feel self-sufficient for training purposes, and even in the case of those that usually do the need does arise at times for advanced information on subjects away from their own lines of specialism; there is then no hesitation in using appropriate postgraduate courses where these exist. Often the need is specific and because of the problem of releasing staff from duty the shorter course is sought. The demand for shorter more specific courses has led to an interesting development in some postgraduate courses offered; a full session's course may be organised into a series of short self-contained units and students accepted for a single unit only. There is

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* Engineering Design, report by the Department of Scientific and Industrial Research, June, 1963.

no doubt that this arrangement meets the needs of industry. Other academic institutions, however, feel this is making the full sessional course educationally unsound and are considering the possibility of offering three separate terms on a sandwich basis. In discussion some companies indicated courses of interest to them but for which they felt insufficient provision at present existed. These are listed in Appendix 8.

66. The problem of release of staff has been covered in some detail in paragraphs 57 and 58 in the case of production staff, and although the difficulty may not be quite so great in the case of other types of staff much the same considerations apply. There is great resistance from industry, and to a certain extent from staff too, to courses of a year's duration. Young staff can be spared more easily than older more experienced staff, and they are keener to attend postgraduate courses, but management need to be really convinced of the value to them of a long postgraduate course before they will agree to the expense and inconvenience of long release. Industry prefer men to have had some industrial experience before they send them on courses, but this may be waived if the need for training is urgent and the calibre of the man is recognised. In a few cases courses of six to twelve months' duration are included as part of a graduate training scheme, partly because it is so much easier to arrange the release while a man is under training and before he settles into a permanent job. It is in the field of graduate training, however, that some forward-thinking firms and organisations feel that much greater liaison between academic institutions and industry is required to produce the right type of postgraduate course. Such a course would be specifically designed to meet the needs of young graduates seeking an initial career in a particular branch of engineering or technology and would be properly integrated with the industrial training given. It would seek to present both academic knowledge and technological application and practice, and the services of both academic and industrial staff would be required. The laboratory in part would be industry itself.

67. Even if industry will not in general contemplate sponsoring a young graduate for a long postgraduate course, they might be expected to be very keen to recruit young men coming out of a postgraduate course. It is, however, a measure of the small value placed on many postgraduate courses that industry does not show itself tremendously eager to recruit their output. Other things being equal, a man who has done a postgraduate course will in general be preferred to a man who has not, but not a great deal of weight is placed on this aspect and industry regard it as more essential to get a man of good basic education and with the right kind of personality and outlook. They can provide any necessary training afterwards in their own way. There are some notable exceptions to this general trend, especially where certain postgraduate courses have become accepted as valuable by certain firms and organisations and in the case of conversion courses producing specialist technologists in short supply.

68. A further reason put forward by academic staff for the reluctance of industry to send staff to postgraduate courses is that industry is just not sufficiently forward looking. It is claimed that much of the material offered in postgraduate courses may not be immediately applicable but may well form the basis of technological change several years ahead, and industry is

not interested because it is not prepared to look so far ahead. It is doubtful whether this criticism can accurately be levelled at many large organisations, but it might be applicable to quite large sections of industry and indeed some sympathy might be felt for this attitude. It is not easy for firms to plan many years ahead, because there are so many imponderables in the situation which can alter at short notice and radically change things. This is a situation not unknown in some large organisations. There is a strong tendency, therefore, to concentrate on more immediate needs which have a more immediate economic bearing. (This is just one aspect of the larger problem of effecting innovation in industry, dealt with more fully in the Annual Report of the Advisory Council on Scientific Policy, 1963–64*.) Considerations such as these have led some senior academic staff to suggest that the only real solution is to take sponsorship of students for postgraduate courses out of the hands of individual firms and finance students out of funds made available through taxes, rates or levies (perhaps through the new Industrial Training Boards).

69. Some academic staff feel that lack of support for postgraduate courses stems from a lack of appreciation of academic studies in general on the part of much of senior management, and that the situation is likely to improve as more graduates reach senior positions. This appears to be rather too simple a view ; management face very real difficulties in releasing staff for the existing types of long postgraduate course and changes in their educational background will not automatically remove these. In any case a good proportion of existing senior staff in many of the larger organisations are in fact university trained. The introduction of more graduates at higher levels will perhaps make an approach easier between universities and industry, but positive steps are still needed from both sides to bridge the gulf that exists. Industry needs clearly to define its training needs, and universities to plan postgraduate courses taking cognisance of these needs.

70. Academic staff at universities and colleges offering the longer advanced courses feel strongly that industry does not appreciate the educational value of such courses to the student. Even if the student does not take away with him a lot of information immediately applicable to his job, this relatively long exposure to academic discipline enables him to return to his firm with a fresh and more confident approach to problems. The bulk of industry appears to attach little weight to this general broadening effect, although some employers have commented on the greater maturity and usefulness of staff returning from long courses.

Rate of Technological Change

71. It has already been pointed out that industry makes far more use of short courses and conferences than they do of the long postgraduate courses. As the rate of technological change increases the need for periodic refresher courses for industrial staff is going to become greater, and the need will be for short rather than long courses. Reference has been made earlier to the need to convince really senior management of the value of postgraduate courses, and the short appreciation course of one or two days on new developments designed specially for them is one way of doing this. Certain

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* Annual Report of the Advisory Council on Scientific Policy, 1963–64, Cmnd. 2538, December, 1964, paras. 26–46.

universities and colleges have run very successful short courses and conferences for all grades of staff, but their organisation is such that these place a great strain on the academic staff. If industrial needs are to be met, then a more positive approach to the provision of short courses is called for. It may be noted that a number of American universities and colleges have already taken steps to provide the short and part-time refresher courses that industry requires*.

Content of First Degree Course

72. There is a good deal of accord between industry and the universities in their views about the first degree course. Industry would like to see a broad-based first degree course, particularly in the field of engineering, but they also have need of the specialist. The existing type of first degree course is already very much crammed with information and most university departments find it more and more difficult to approach the frontiers of knowledge (a position realised by the Robbins Committee†), so the suggestion is that a more general type of engineering first degree course would be appropriate, to be followed for those showing the necessary academic ability by a postgraduate course adding the specialisation required. These two courses might well be separated by a short period of experience in industry, but here opinions differ and this may well be a matter depending upon the individual needs of the student. Some postgraduate courses already tend to be of this nature (paragraph 55(*b*)(ii) above), but this would extend them and make them part of a general pattern. There are several advantages of such a scheme: for many production jobs a high degree of specialisation is not required; the broader based training would be an advantage to the specialist engineer both in his immediate job and when he assumes more senior positions; and the specialist training could be better given in a postgraduate environment. This idea of a broad-based initial education has a great deal of support in many quarters, and a number of courses towards this end are already in existence. Certain of the newer universities are preparing to offer general-type engineering first degree courses. The reason for dealing with the matter here is the repercussion it will have on the requirement for postgraduate courses, and on such an extended scale and as an integral part of the engineering education there seems every reason for not regarding such provision as a burden on industry but to finance it from central or local funds.

D.S.I.R. Grants

73. The existing system of grants to students by the Department of Scientific and Industrial Research (D.S.I.R.) for postgraduate courses attracts a fair degree of criticism from university departments. The scheme normally restricts awards to holders of first and second class honours degrees, although universities feel that many other men, especially those with good higher national certificates and diplomas backed by sound industrial experience, are capable of profiting from postgraduate courses. The greater complaint, however, is that the scale of D.S.I.R. grants is quite insufficient for the man who has had two or three years in industry and whose salary may be in the

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* e.g. Northeastern University established a special "Centre for Continuing Education in Engineering" in 1963.

† Report on Higher Education, Cmnd. 2154, October, 1963, paras. 254, 293.

region of £1,000 a year. Often he is the good honours graduate who went straight into industry and who would subsequently like to attend a postgraduate course but whose employer is not prepared to sponsor him. A few heads of departments have suggested that block grants might be made to them personally: so that they could dispense awards in the most fitting manner and be accountable for their stewardship afterwards, but this suggestion does not have general support. There is also the feeling that there are many men with several years experience in industry and now in quite senior positions who would particularly benefit from a long postgraduate course. There should be D.S.I.R. awards available that would enable them to do so without too much financial hardship*.

Research Work

74. There is a strong feeling that postgraduate courses seeking to give information and experience of a really advanced nature need to draw on an active and successful research programme. This indeed is the context within which many postgraduate courses are offered by university departments, but there is a feeling that British industry often tends to ignore the universities as centres of fundamental and even applied research, sometimes perhaps through ignorance of their existence. This apparent lack of support and interest has adverse repercussions on the development of the postgraduate courses. Many feel that the research facilities of university departments are not adequately appreciated and that there needs to be closer liaison between them and industrial and government centres of research and development (a situation envisaged by the Robbins Committee†.) Some of the most successful postgraduate courses are to be found in departments where academic staff have really made big efforts to establish this close liaison. In particular it is felt that such liaison would be stimulated if industrial research centres were on appropriate university sites and worked in close association with the university departments there.

Secondment

75. In view of the importance of establishing closer contacts between industry and the universities, the question of secondment of staff was explored in some detail. First there is the possibility of seconding staff from industry to assist with the work in university departments. If this is considered on a full-time basis, then the difficulties of release from normal duty come up again. To be really effective, staff of good calibre and experience are required and this means they are going to be in the more senior positions. These are the men industry can least spare, and full-time secondments for as long as a year do not seem possible. The firms and organisations will not contemplate this and the staff themselves do not wish to be absent so long. The larger organisations tend to look favourably on a possible full-time secondment of from three to six months, and indeed see certain advantages in this; it can have a broadening effect on the member of staff seconded and it can give useful experience to his deputy. The universities, however,

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* It is for these men that the D.S.I.R. Industrial Fellowship scheme was initiated in 1964. Industrial fellows will generally be paid at rates comparable with the salaries which men of their ages and qualifications could normally expect to command in industry or in an academic appointment, but within a maximum of £2,000 per annum.

† Report on Higher Education, Cmnd. 2154, October, 1963, para. 402.

seem only lukewarm towards full-time secondments of this duration. It really takes an appreciable time for a man to settle down and become an effective member of the academic staff. They would prefer the services of an industrialist on a part-time basis regularly over a period of a few years. This arrangement, of course, puts considerable strain on the individual man concerned since in effect he has to carry on his own industrial job and perform the academic work as well. If the academic load is not too heavy and the man concerned has a competent staff to fall back on, then this arrangement is a possibility, and a small number of universities have already made arrangements with large industrial organisations for the appointment of part-time or visiting professors and lecturers. In these cases the industrial organisation continues to pay the member of staff his normal salary.

76. In many firms, of course, individual members of staff give occasional lectures and help in several ways such as serving on governing bodies of colleges and on advisory boards for particular subjects. Industry is sympathetic towards any official approach for such services. The value of these boards seems to be not so much in what is achieved in formal business but the way in which the contacts between academic staff and industrial staff can be developed on an informal basis.

77. There is also the question of seconding academic staff for periods of experience in industry. Industry is quite willing to arrange such periods of experience and will often contribute towards additional expenses incurred by the member of staff, but in general it feels that the man cannot make a contribution to justify the payment of a salary and that the academic institution should continue to do this. Relatively few academic staff take advantage of the facilities offered, and these seem mainly from technical colleges. Many academic staff doubt whether there is much advantage to be gained from such secondments and feel that they can keep in touch with industrial developments through personal liaison of an ad hoc character, often through arrangements for vacational work and projects for undergraduates, research contracts, and consultancy work. A few large organisations have recently offered industrial fellowships to academic staff to give one or two years working experience in industry, but as yet there does not seem to have been a great response. While there does not seem a great deal of enthusiasm generally for secondments of staff either way, anything that can be arranged is a useful reinforcement of the many individual efforts that are needed in other directions to bridge the gulf between industry and the universities.

Information about Postgraduate Courses

78. During discussions it became apparent that information in industry about postgraduate courses is on a very haphazard basis. Regional Advisory Councils publish information about certain kinds of postgraduate courses but their publications by no means reach all the firms who may be interested. In any case, the information given usually excludes the longer courses and all the courses organised by universities. When university departments offer postgraduate courses they try and give wide publicity to them by sending particulars to certain firms and organisations, to their various personal contacts, and by advertising in certain journals, but there is no guarantee that the information reaches all those in industry who may be interested. In large organisations information about postgraduate courses is normally held

centrally in training departments and disseminated by them, but there is no way of knowing how complete the information is. There is strong support for the suggestion that some central clearing office should take responsibility for obtaining comprehensive information about postgraduate courses, especially the longer courses, and for disseminating this information in a comprehensive but summarised form to industry. Any firm interested in a particular course could then get into touch with the university or college department concerned. An elaborate organisation is not required but a number of suggestions have been put forward as to who might undertake this task. The Department of Education and Science, Her Majesty's Stationery Office, the British Association for Commercial and Industrial Education, the professional institutions (with perhaps the Council of Engineering Institutions acting for the whole of engineering) and a number of industrial associations have all been mentioned. It is interesting to note that at least one professional engineering institution has already started such a service for its members.

Coordination of Industrial Needs

79. Training needs keep arising in industry and very often these are quite specific and apply only to one or two individuals in a firm. If existing postgraduate courses of the right kind cannot be traced, then university departments or colleges are often approached to see if they are willing to mount a special course. If the interest of other firms cannot be stimulated, then a course cannot usually be arranged for just the one or two individuals. There is no machinery for co-ordinating training needs of this kind, yet it is possible that nationally there might be sufficient demand to justify particular courses being started. It has been suggested that the clearing office suggested in the previous paragraph might also be used to receive and co-ordinate such requests for new postgraduate courses. Some machinery also seems desirable to try and create a viable course from courses of a similar nature at different universities which attract only very few students each, but there are obvious difficulties in trying to effect this kind of co-ordination.

Staff Planning and Career Development

80. The general picture emerging from this enquiry is that of many university departments proposing postgraduate courses and trying to arouse the interest of industry in them. In industry the procedure is to look at these courses and see if they are likely to be of material value to staff. It becomes very much a question of looking for staff to fit courses. In general, industry produces little support for these courses and if they run they are in the main attended by students straight from their first degrees, by men from industry who temporarily give up their jobs in the hope of increasing their market value, and by a substantial number of overseas students. Even where industry does send students to particular postgraduate courses this is often because of the interest and influence of certain senior men in a few firms, and if these men move away the support can quickly collapse. One can sympathise with the universities to some extent, because they have taken the initiative to organise these longer postgraduate courses and often with such disappointing results. The mood in industry is changing, however, and more emphasis is gradually being placed on staff planning and career development for

the individual. This trend should show up training needs much more clearly and well in advance, and there is the hope that industry will increasingly be able to ask for courses to meet the precise needs of their staff. The production of postgraduate courses will then be much more of a co-operative effort between industry and the universities.

Acknowledgments

The author is grateful for the interest and co-operation shown by industrial representatives and academic staff whom he asked for information and views through the questionnaire or during visits. He is also grateful for the assistance afforded by the Department of Education and Science in mounting the enquiry and analysing the questionnaire and especially for the expert statistical guidance provided. He is indebted too, to the United Kingdom Atomic Energy Authority for granting the time to make this enquiry possible.

In Confidence

Questionnaire on postgraduate courses in engineering and technology

GENERAL NOTE

This questionnaire is divided into the following parts—

Part I Summary of courses available in session 1964/65.

Part II Assessment of courses.

Part III Numbers of students attending courses in session 1963/64 and enrolled in October 1964.

Part IV Data sheets for each student enrolled in October 1964.

Parts I to IVA are designed for completion by or on behalf of the Head of the Department and Part IVB by the students themselves.

It is hoped that all parts of the questionnaire can be returned together by the Head of Department by *26th October* to:

H. Arthur
Department of Education and Science
Richmond Terrace
London, S.W.1.

Questionnaire on postgraduate courses in engineering and technology

1. The term postgraduate courses may be interpreted in two ways. In one way, perhaps the normal way, the term indicates courses of an advanced nature taken by graduates of the appropriate discipline; but it can also be taken to mean courses organised for graduates to give them instructions in new subjects not necessarily at an advanced level. An example of the second interpretation is the conversion course which may be organised to enable graduates of other disciplines to undertake work with an engineering content. Courses under both interpretations should be included, but as clear a reference to their nature as possible should be made in column 2 of Part I (e.g. ' conversion ').

2. This survey is into postgraduate formal instructional courses and not into research work leading to higher degrees, but it is realised that the two are not always clearly separated. A relatively short research project is often part of a course which is largely formal instruction, in which case the course should be included and the existence of a research project indicated in Part I. Sometimes postgraduate students pursuing research work leading to higher degrees are required to attend one or more formal courses run partly or wholly for research students. Formal courses run wholly for research students should not be included in Part I, and research students attending formal courses run only partly for their benefit should not be included in the numbers to be given in Parts III A and B. All research students, whether attending formal courses of instruction or not, should be included in Part III C.

3. There could be confusion about what is meant by engineering and technology. To give some guidance a list of subjects indicating the scope of the enquiry is given below:

Chemical Engineering

Chemical engineering, chemical technology, combustion engineering, gas engineering.

Civil and Structural Engineering

Building, civil engineering, gas supply, municipal engineering, sanitary engineering, structural engineering, water engineering, water supply and purification.

Electrical Engineering

Applied electronics, electrical engineering, electronic engineering, electronics, power generation, radio engineering, telecommunications.

Mechanical Engineering

Aeronautics, aeronautical engineering, agricultural engineering, automation engineering, automobile engineering, aviation, industrial engineering, marine engineering, mechanical engineering, mechanical science, naval architecture, refrigerating engineering.

Mining Engineering

Metalliferous mining, mining engineering, mining surveying.

Metallurgy

Metallurgical engineering, metallurgical chemistry, metallurgy, physical metallurgy.

Others

Biological engineering, brewing technology, ceramic technology, engineering sciences, fuel engineering, fuel technology, glass technology, malting and brewing, nuclear engineering, petroleum technology, plastics technology, production engineering, rubber technology, textile technology, wool textiles.

4. There could also be confusion over the term " graduate ". By this is meant a person with a degree or a Diploma in Technology, or who has been recognised as a graduate member of a major professional institution. To certain courses primarily designed for graduates, some students with slightly lower qualifications may be admitted, e.g. students with a Higher National Diploma or a Higher National Certificate. Such students should be included for the purposes of Parts III and IV of this questionnaire.

5. Reference is made in Part I to courses of sessional duration. It is realised that a session can mean a different thing for particular courses at different universities and colleges. As a minimum it should be taken as the normal undergraduate session of eight or nine months, but there is the opportunity in column 3 to indicate its exact length in months.

6. In general, if there is any doubt about a particular course it should be included with appropriate remarks.

In Confidence

Postgraduate courses in engineering and technology(a)

Part I. Courses available in session 1964/65

University or college..

Department ....

	Leave blank

Name of course (1)	Nature of course (2)	Duration (in months) (3)	Subject coverage of course (4)	Qualification awarded on successful completion (5)	By whom was course initiated ?(*b*) (6)	Date of initiation of course (7)	Leave blank (8)
A. *Courses of sessional or longer duration*							
(1)							
(2)							
(3)							
(4)							
(5)							
(6)							
(7)							
(8)							
(9)							
(10)							

	Leave blank

Name of course (1)	Nature of course (2)	Duration (in months) (3)	Subject coverage of course (4)	Qualification awarded on successful completion (5)	By whom was course initiated ?(*b*) (6)	Date of initiation of course (7)	Leave blank (8)
B. *Shorter courses* (1)							
(2)							
(3)							
(4)							
(5)							
(6)							
(7)							
(8)							
(9)							
(10)							

(*a*) Only courses of at least one month's duration involving organised formal instruction of full-time students should be included. Please read attached notes before completing the questionnaire.

(*b*) Specify whether the Department; industry; a government establishment (state which); or other organisation (state which).

In Confidence

Part II. Assessment of courses listed in Part I

1. How enthusiastic has been the response and support of actual or prospective employers of the United Kingdom students concerned ?

2. What part have men, whose primary employment is in industry, government establishment, or other, played in the teaching work of the course ?—numbers and brief particulars of time spent during the period of the course.

3. What academic status, if any, is given to these lecturers ?—e.g. special lecturer, industrial reader, visiting professor.

4. Any comments on the difficulties which you find to be associated with the fuller development of postgraduate courses of sessional duration.

(The course numbers below refer to the courses shown against these same numbers in Part I)	Support of employers (question 1 above)	Teaching (question 2 above)	Academic status of outside lecturers (question 3 above)	Difficulties (question 4 above)
A. *Courses of sessional or longer duration* (1)				
(2)				
(3)				
(4)				
(5)				
(6)				
(7)				
(8)				
(9)				
(10)				

(The course numbers below refer to the courses shown against these same numbers in Part I)	Support of employers (question 1 over)	Teaching (question 2 over)	Academic status of outside lecturers (question 3 over)	Difficulties (question 4 over)
B. *Shorter courses* (1)				
(2)				
(3)				
(4)				
(5)				
(6)				
(7)				
(8)				
(9)				
(10)				

Part III. The number of students attending courses or doing research in session 1963/4 *and* 1964/5

(The course numbers below refer to the courses shown against these same numbers in Part I. Additional courses run in session 1963–64 should be added at the end)	1963–64	1964–65
A. *Courses of sessional or longer duration* (at October) (1)		
(2)		
(3)		
(4)		
(5)		
(6)		
(7)		
(8)		
(9)		
(10)		

	Give below date course started			
			Leave blank	Oct., 1964
B. *Shorter courses* (11)				
(12)				
(13)				
(14)				
(15)				
(16)				
(17)				
(18)				
(19)				
(20)				

C. *Research* (at October) All full-time students proceeding to higher degrees by research		

In Confidence

Part IV. Personal data sheet on students in postgraduate courses in 1964/65

A. *For completion by Department*

	Leave blank
Name	....
University or college....................	....
Department	....
Course (as shown in Part I)....................	....
Qualification for which registered.................... (e.g. Diploma, M.Sc. certificate)	....
Country of origin....................	....
First degree (or other qualification.................... obtained before entry to course)	....
Subject	....
University or college.................... (if overseas, state country)	....
Date of qualification....................	....
Nature and duration of education or employment between graduation and start of course....................	....
Source of grant (if none state " none ")	....

B. *For completion by student*

Leave blank

Please indicate, by ticking the most appropriate box, what you are planning to do when your present course is completed.

1. Research for higher degree at:

this university	☐	1
another university or C.A.T. in U.K.	☐	2
overseas: U.S.A.	☐	3
Canada	☐	4
Australia and New Zealand	☐	5
Other	☐	6

2. To take up or resume teaching in:

this university	☐	7
another university or C.A.T. in U.K.	☐	8
technical college, training college or school in U.K.	☐	9
overseas: U.S.A.	☐	10
Canada	☐	11
Australia and New Zealand	☐	12
Other	☐	13

3. To take up, or resume, other employment in:

		Leave blank
(*a*) U.K.		
industry or public corporations:		
research and development department ..		14
design department		15
production department (inc. power generation)		16
management (trainee)		17
industrial research associations		18
government departments (including research councils)		19
firms of consultants		20
other		21
(*b*) overseas: U.S.A.		22
Canada		23
Australia and New Zealand		24
Other		25

Appendix 2(a)

Letter sent to Heads of Departments

Department of
Education and Science
Richmond Terrace, Whitehall, London, S.W.1.

1st September, 1964.

Dear

One of the subjects to which the Committee on Scientific Manpower is turning its attention is that of *post-graduate courses of study* in engineering and allied technological subjects, as distinct from post-graduate research in these fields. The Secretary of the Committee of Vice-Chancellors and Principals has kindly informed us of the survey of these courses which the Committee has recently carried out, and we should now like to follow up this survey to obtain more comprehensive information covering such questions as the number and nature of the student participants; the degree to which the courses are assisting science graduates to prepare themselves for technological employment, are catering for overseas students, and are attracting men back from industry; and the extent of the support which the courses are receiving from employers in the conduct of the teaching work.

With the approval of the University Grants Committee, the Department of Education and Science and the Department of Scientific and Industrial Research, I am, therefore, writing to the Heads of the Departments of Engineering and of Technology of the Universities to ask if they will assist the Committee on Scientific Manpower by providing, in answer to the enclosed questionnaire, information about their respective courses and student participants. It is intended to supplement the questionnaire by visits should this prove necessary. I am writing similarly to the Principals of the Colleges of Advanced Technology and of certain other Colleges of Technology.

I shall be most grateful on behalf of the Committee if you will help by providing the information requested by the date mentioned in the questionnaire.

Yours sincerely,

WILLIS JACKSON

Appendix 2(b)

Letter to Vice-Chancellors

Department of
Education and Science
Richmond Terrace, Whitehall, London, S.W.1.

1st September, 1964.

Dear

One of the subjects to which the Committee on Scientific Manpower is turning its attention is that of *post-graduate courses of study* in engineering and allied technological subjects, as distinct from postgraduate research in these fields. The Secretary of the Committee of Vice-Chancellors and Principals has kindly informed us of the survey of these courses which the Committee has recently carried out, and we should now like to follow up this survey to obtain more comprehensive information covering such questions as the number and nature of the student participants; the degree to which the courses are assisting science graduates to prepare themselves for technological employment, are catering for overseas students and are attracting men back from industry; and the extent of the support which the courses are receiving from employers in the conduct of the teaching work.

With the approval of the University Grants Committee, the Department of Education and Science and the Department of Scientific and Industrial Research, I am, therefore, writing to the Heads of the Departments of Engineering and of Technology of the Universities (see attached) to ask if they will assist the Committee on Scientific Manpower by providing, in answer to the enclosed questionnaire, information about their respective courses and student participants. It is intended to supplement the questionnaire by visits should this prove necessary.

I shall be most grateful on behalf of the Committee if you will give your support to this enquiry since I am sure you will appreciate the need to ensure that the replies received are comprehensive. I am writing similarly to the Principals of the Colleges of Advanced Technology and of certain other Colleges of Technology, and also, by agreement with the Scottish Education Department, to the Heriot-Watt College, Edinburgh.

Yours sincerely,

Willis Jackson

Appendix 2(c)

Letter sent to Principals of Colleges of Technology

Department of
Education and Science
Richmond Terrace, Whitehall, London, S.W.1.

1st September, 1964.

Dear

One of the subjects to which the Committee on Scientific Manpower is turning its attention is that of *post-graduate courses of study* in engineering and allied technological subjects, as distinct from postgraduate research in these fields. The Committee is anxious to obtain comprehensive information about the existing courses in respect of such questions as the subject coverage; the number and nature of the student participants; the degree to which the courses are assisting science graduates to prepare themselves for technological employment, and catering for overseas students and are attracting men back from industry; and the extent of the support which the courses are receiving from employers in the conduct of the teaching work.

With the approval of the Department of Education and Science, the University Grants Committee and the Department of Scientific and Industrial Research, I am, therefore, writing to ask if you will assist the Committee on Scientific Manpower by arranging for your Heads of Departments to let me have the information requested in the attached questionnaire concerning their respective fields. I shall be most grateful for their, and your help since I am sure you will appreciate the need to ensure that the replies received are comprehensive. If necessary, the questionnaire can be supplemented by a visit by a member of staff of the Secretariat of the Committee.

I am writing similarly to the Vice-Chancellors and Heads of the Technological Departments of the Universities.

Yours sincerely,

Willis Jackson

List of Industrial Organisations Visited

British Aircraft Corporation Ltd.
Central Electricity Generating Board
Davy-Ashmore Ltd.
Elliott-Automation Ltd.
English Electric Co., Ltd.
Esso Petroleum Company Ltd.
Thomas Firth and John Brown Ltd.
General Electric Company
Glaxo Group Ltd.
Imperial Chemical Industries
International Computers and Tabulators Ltd.
Metal Box Company Ltd.
Pilkinton Brothers Ltd.
Plessey (U.K.) Ltd.
Rolls Royce Ltd. (Motor Car Division)
Sir Robert McAlpine & Sons Ltd.
Steel Company of Wales Ltd.
Tube Investments Ltd.
Unilever Ltd.
United Kingdom Atomic Energy Authority (Northern Groups)

Appendix 4

Letter sent to Chairmen of Industrial Organisations

Department of
Education and Science
Richmond Terrace, Whitehall, London, S.W.1.

July, 1964.

Enquiry into Postgraduate Courses in Technology

Considerable attention has been given recently to the growth of Postgraduate Courses in Technology in universities and similar institutions. The Committee of Vice-Chancellors and Principals has recently undertaken a preliminary enquiry into these Courses, and the Committee on Scientific Manpower is now following this up with an enquiry both in the universities and in industry on how far these Courses are supported by industry and meet its requirements.

We have engaged an investigator, Mr. Herbert Arthur, Group Training Officer of the Production and Engineering Groups of the Atomic Energy Authority, to help us in this enquiry. During the next six months Mr. Arthur will be engaged in a round of consultations in universities and in industry to discuss the following questions:—

(1) The nature of the financial assistance afforded by actual or prospective employers of the students concerned.

(2) The formal arrangements between industry and education organisations for the conduct of the courses.

(3) The participation by staff members of industry and other non-teaching institutions in the teaching work.

(4) The value which employers attach to the Courses and proposals for their future development.

Mr. Arthur is now ready to commence his visits, and I am, therefore, writing to you and to a number of other industrialists who have been closely associated with the work of the Committee on Scientific Manpower and other aspects of Government scientific policy to ask if you would be so good as to permit Mr. Arthur to discuss these issues with appropriate persons in your organisation in the near future. He is planning to make his industrial visits from the middle of August onwards. Concurrently with this, a questionnaire is going to universities and similar institutions which Mr. Arthur will be visiting later. It is hoped to complete the overall investigation by the end of the year.

I think that you agree that it is important to ensure that Courses of this kind are closely related to the needs of industry, and I hope that you will be able to give us guidance on how they may best be developed.

I shall be most grateful if you will let me know the name and telephone number of the person with whom Mr. Arthur might seek to arrange a meeting.

Yours sincerely,

WILLIS JACKSON

Appendix 5

Postgraduate Courses in Engineering and Technology

INDUSTRIAL VISITS

Firm.. Date.............................
Discussion with...
....
....

Matters for discussion	Views
Broad Views	
1. Feelings about enquiry: (*a*) Nature	Important/N. Imp.
(*b*) Scope	Satisf./N. satisf.
2. Much merit in postgraduate courses?	Yes/No.
Value of Existing Courses	
3. Is there conscious effort to recruit graduates who have undertaken	
(*a*) postgraduate courses?	Yes/No. Courses:—
(*b*) research for higher degree?	Yes/No. Subjects:—
4. Basis for policy	
5. (*a*) Is there sponsorship of staff for courses?	Yes/No. Courses and numbers:—
(*b*) Method of selection.	
(*c*) Aid given	Salary/Fees/Leave of absence.
(*d*) After how much industrial experience?	
(*e*) Evaluation of courses.	
(*f*) Attitude of staff.	
6. Integration of courses with internal training schemes.	
7. Is there adequate information about available courses?	Yes/No.

Involvement in Courses

8. Representation on bodies formulating courses.
9. Help given with particular courses: Yes/No. Courses:—
    (*a*) Equipment
    (*b*) Visiting facilities
    (*c*) Lectures
10. (*a*) Secondment of staff to universities and colleges
    (*b*) Giving experience to academic staff.

Matching Demand and Supply

11. Is further development of postgraduate courses required? Yes/No.
12. Known specific needs not satisfied.
13. Efforts made to get suitable courses.
14. Machinery which could be effective:
    (*a*) For industry/colleges to get together.
    (*b*) For rationalisation of providing courses.
    (*c*) For dissemination of comprehensive information.
    (*d*) For looking ahead at future requirements.

Views on First Degrees

15. Are new graduates satisfactory? Yes/No.
16. What are deficiencies?
17. How might these be overcome?
18. Extent of specialisation, and repercussions on postgraduate courses.

Other matters raised

Appendix 6

List of Universities and Colleges Visited

Battersea College of Advanced Technology
Birmingham College of Advanced Technology
Birmingham University
Borough Polytechnic
Brunel College of Advanced Technology
College of Aeronautics
Edinburgh University
Heriot-Watt College
Imperial College of Science and Technology
Leeds University
Manchester University
Manchester College of Science and Technology
National College of Heating, Ventilating, Refrigeration and Fan Engineering
National College of Rubber Technology
Newcastle-upon-Tyne University
Northampton College of Advanced Technology
Sheffield University
Strathclyde University
Swansea University College
Welsh College of Advanced Technology

Appendix 7

Postgraduate Courses in Engineering and Technology

	Duration (in months)	*Award*
Queen's University, Belfast		
Applied Electronics and Communications	8/16	M.Sc.
Birmingham University		
Chemical Engineering	12	M.Sc.
Biological Engineering	12	M.Sc.
Petroleum Production Engineering	12	Diploma
Information Engineering	12	M.Sc./Dip.
Theory of Electrical Machines	12	M.Sc./Dip.
Solid-State Electronic Engineering	12	M.Sc./Dip.
Engineering Production	12	M.Sc./Dip.
Operational Research	12	M.Sc.
Quality and Reliability Engineering	12	M.Sc./Dip.
Work Design and Ergonomics	12	M.Sc./Dip.
Highway and Traffic Engineering, Highway Materials and Management	12	M.Sc./Dip.
Brewing Science	12	M.Sc.
Malting and Brewing	12	Diploma
Foundation Engineering	12	M.Sc./Dip.
Science of Founding	12	M.Sc.
Reactor Physics and Technology	12	M.Sc.
Thermodynamics and Related Studies	12	M.Sc.
Cambridge University		
Chemical Engineering Tripos	24	B.A.
Theory of Structures and Strength of Materials	9	Certificate
Control Engineering	9	Certificate
Postgraduate Study	12	Certificate
Edinburgh University		
Applied Dynamics	8	Diploma
Mechanical Vibrations	2	—
Gyrodynamics	1	—
Electronics and Control	9	Diploma
Glasgow University		
Industrial Administration	9	Certificate
Leeds University		
Metallurgy	9	Diploma
Concrete Technology	9	Diploma
Structural Engineering	12	M.Sc.
Bearing Design, Lubrication, Friction and Wear	12	M.Sc.
Chemical Engineering	12	Diploma
Engineering Design	21	Diploma
Textile Technology	21	Diploma
Special Textile Technologies (International Wool Secretariat)	3	—
Ceramics	9	Diploma
Fuel Science	9	Diploma

Postgraduate Courses in Engineering and Technology (*continued*)

	Duration (in months)	*Award*
Liverpool University		
Power Plants and Related Subjects	9	M.Eng.
Building Science	9	Diploma
Acoustics	12	M.Sc./M.Eng.
Traffic Studies	9	M.Eng./Dip.
London University—Imperial College of Science and Technology		
Concrete Structures and Technology	9	Diploma
Structural Engineering	9	M.Sc./Dip.
Public Health Engineering	9	M.Sc./Dip.
Transport	9	M.Sc./Dip.
Soil Mechanics	9	M.Sc./Dip.
Hydro-power, River Structures and Fluid Mechanics	9	Diploma
Engineering Hydrology	9	M.Sc./Dip.
Electrical Machines and Power Systems	9	Diploma
Communications and Electronics	9	Diploma
Automatic Control Systems	9	M.Sc./Dip.
Electric Traction	9	Diploma
Engineering in Medicine	9	Diploma
Science of Materials	9	M.Sc./Dip.
Engineering Geology	9	Diploma
Petroleum Reservoir Engineering	9	Diploma
Mineral Exploration	9½	Diploma
Petroleum Geology	10	Diploma
Nuclear Technology	12	M.Sc./Dip.
Advanced Chemical Engineering	12	M.Sc./Dip.
Chemical Engineering	12	Diploma
Statistics and Operational Research	11	Diploma
Photoelectronics	9	Diploma
Aeronautics	9	M.Sc./Dip.
Applied Mechanics	9	Diploma
Thermal Power and Process Engineering	9	Diploma
Production Engineering	9	Diploma
Operational Research and Management Studies	9	Diploma
Nuclear Power	9	Diploma
London University—King's College		
Powder Technology	12	Diploma
Electronics	12	M.Sc.
Chemical Engineering	9	Diploma
London University—Queen Mary College		
Electrical Engineering Systems	9	M.Sc.
Electrical Properties of Matter	6	Diploma
London University—University College		
Chemical Engineering	9	Diploma
Biochemical Engineering	9	Diploma
Microwave Engineering	12	M.Sc./M.Eng./Dip.
Photogrammetry	9	Diploma
Surveying	9	Diploma

Postgraduate Courses in Engineering and Technology (*continued*)

	Duration (*in months*)	*Award*
Manchester University		
Structures	12	Diploma
Nuclear Engineering	12	Diploma
Reactor Physics	1	Certificate
Heat Transfer	1	Certificate
Automatic Computation	1	Certificate
Soil Mechanics	12	Diploma
Manchester University—College of Science and Technology		
Industrial Design Technology	12	M.Sc.
Building Site Technology and Management	1½	—
Electrical Power Systems Engineering	12/19	M.Sc.
Theory and Practice of Automatic Control	12/19	M.Sc.
Applied Electronics	12/19	M.Sc.
Solid State Electronics	12/19	M.Sc.
Electrical Machines	2	—
Power Systems	2	—
Control Systems	2	—
Applied Electronics	2	—
Machine Tool Technology	12/21	M.Sc.
Production Engineering	9	Diploma
Machine Tool Technology and Design	24	Associateship
Advanced Engineering Studies	2	—
Corrosion Science	12	M.Sc.
Newcastle University		
Mechanical Engineering	12	M.Sc.
Production Engineering	9	Diploma
Marine Engineering	9	Diploma
Coal Preparation	9	Certificate
Ore Dressing	9	Certificate
Rock Mechanics and Strata Control	12	M.Sc.
Rock Mechanics	3	—
Applied Electronics	9	Certificate
Applied Electronics	9	Diploma
Electrical Power Engineering	9	Certificate
Electrical Power Engineering	9	Diploma
Public Health Engineering	9	Certificate
Public Health Engineering	9	Diploma
Public Health Engineering	12	M.Sc.
Highway and Traffic Engineering	9	Diploma
Hydrology	9	Diploma
Chemical Engineering Science	12	M.Sc.
Sheffield University		
Rock Mechanics	1	—
Mining	9	Diploma
Mine Ventilation	1	—
Glass Technology	9	Diploma
Glass Technology	9	Associateship
Physical Metallurgy	10	M.Met.

Postgraduate Courses in Engineering and Technology (*continued*)

	Duration (in months)	*Award*
(*continued*)		
Physical Metallurgy	24	M.Met.
Applied Mechanics	6¼	Diploma
Electronics for Engineers	1¼	—
Stress Determination	1¼	—
Gear Design	1¼	—
Servomechanisms and Automatic Control	1¼	—
Mechanical Vibration	1¼	—
Friction, Wear and Lubrication	1¼	—
Southampton University		
Electronics	9	Diploma
Electronics	12	M.Sc.
Structural Engineering	12	M.Sc./Dip.
Irrigation and Land Drainage Engineering	12	M.Sc./Dip.
High Temperature Gas Dynamics	12	M.Sc./Dip.
Vibration and Noise Studies	12	M.Sc./Dip.
Advanced Acoustics	12	M.Sc./Dip.
Strathclyde University		
Naval Architecture	12	M.Sc.
Naval Architecture	9	Certificate
Extraction Metallurgy	9/12	Diploma
Mining Geology	9/12	M.Sc./Dip.
Applied Geophysics	9/12	M.Sc./Dip.
Industrial Management	9	Certificate
Environmental Control Engineering and Resource Utilisation	9/12	M.Sc./Dip.
Hydraulics	9/12	M.Sc./Dip.
Public Health Engineering	9/12	M.Sc./Dip.
Chemical Process Development	11	Diploma
Structural Engineering	9/12	M.Sc./Dip.
Traffic and Highway Engineering	9/12	M.Sc./Dip.
Production Engineering	9	M.Sc./Dip.
Bioengineering	12	M.Sc.
Mechanical Engineering	11	M.Sc./Dip.
Nuclear Reactor Design	9	M.Sc./Dip.
Power Engineering	9	M.Sc./Dip.
Wales University—University College of Swansea		
Chemical Engineering	11	Diploma
Chemical Engineering	12	M.Sc.
Structural Mechanics	12	M.Sc.
Fluid Mechanics	12	M.Sc.
Soil Mechanics	12	M.Sc.
Heat Transfer and Gas Dynamics	12	M.Sc.
Mechanical Power Transmissions	12	M.Sc.
Electrical Energy-Generation and Transmission	12	M.Sc.
Control Engineering	12	M.Sc.
Communications	12	M.Sc.
Electronic Materials and Devices	12	M.Sc.

Postgraduate Courses in Engineering and Technology *(continued)*

	Duration (in months)	*Award*
Wales University—University College of North Wales		
Electrical Materials Science	12	M.Sc.
Wales University—University College of South Wales		
Solid State Theory	12	M.Sc.
Battersea College of Advanced Technology		
Highway Engineering	9	Diploma
Structural Engineering	9	Diploma
Bridge Engineering	9	Diploma
Control Engineering	9	Diploma
Computer Systems	9	Diploma
Microwave Physics	12/24	Diploma
Rheology	12	Diploma
Chemical Engineering	9	Diploma
Birmingham College of Advanced Technology		
Numerical Control of Machine Tools	12	M.Sc.
Principals of Production Engineering	3	Certificate
Mechanics of Solids	12	M.Sc.
Applied Plasticity	12	M.Sc.
Technology of Rolling	1	Certificate
Chemistry and Technology of Polymers	12	M.Sc.
Chemical Engineering	12	Certificate
Electrical Engineering	12	M.Sc.
Precision Measurement and Instrumentation	12	M.Sc.
Nuclear Technology	2½	—
Bradford College of Advanced Technology		
Chemical Engineering	9	Diploma
Powder Technology	9	Diploma
Automation in Chemical Industry	9	Diploma
Textile Technology	9	Certificate
Recent Advances in Man-Made Fibre Technology	1½	—
High Polymer Chemistry	9	Diploma
Dyestuffs and Dyeing Technology	9	Diploma
Metals Technology	9	Diploma
Chelsea College of Science and Technology		
Solid State Physics	12	M.Sc.
Nuclear Physics	12	M.Sc.
Loughborough College of Advanced Technology		
Industrial Engineering and Management	12	M.Tech./Assoc.
Economics and Administration in Petroleum Industry	12	Associateship
Refinery Engineering	12	Associateship
Process Dynamics and Optimisation	12	Associateship
Initial Project Design	1½	—
Ergonomics and Cybernetics	12	Associateship

Postgraduate Courses in Engineering and Technology (*continued*)

	Duration (*in months*)	*Award*
Northampton College of Advanced Technology		
Aerospace Engineering	10	Diploma
Instrument and Control Engineering	12	Diploma
Instrument Design	12	Diploma
Royal College of Advanced Technology		
Production Engineering	6	Diploma
Introduction to Aerodynamics	1	—
Automatic Control in Mechanical Engineering	1¼	—
Noise, Vibration and Fatigue	1½	—
Welding Technology	1½	—
Acoustic Technology	3	—
Science and Technology of Nuclear Power	2	—
Introduction to Reactor Engineering	1	—
Welsh College of Advanced Technology		
Electronics	9	Diploma
Heriot-Watt College		
Technical Biochemistry	9	Associateship
National College of Agricultural Engineering		
Environmental Control-Glasshouses	9/12	—
Field Engineering—Soil Conservation	9/12	—
Tropical Farm Mechanisation	9/12	—
Farm Buildings and Structures	9/12	—
National College of Heating, Ventilating, Refrigeration, and Fan Engineering		
Associateship	9	Associateship
National College of Rubber Technology		
Rubber Science and Technology (for Science Graduates)	9	Associateship
Plastics Science and Technology (for Science Graduates)	9	Associateship
Plastics Science and Technology (for Rubber Graduates)	9	Associateship
National Foundry College		
Diploma Part I	6	Diploma
Part II	9	Diploma
College of Aeronautics		
Airline Engineering	9	Diploma
Aircraft Propulsion	9/21	Diploma
Propulsion Engineering Advanced	9	Diploma
Aerodynamics	9/21	Diploma
Fluid Mechanics	9	Diploma
Space Technology	9	Diploma
Aircraft Design	9/21	Diploma
Solid Mechanics and Structures	9	Diploma
Aircraft Materials	9/21	Diploma
Materials Science	9/21	Diploma

Postgraduate Courses in Engineering and Technology (*continued*)

	Duration (in months)	*Award*
College of Aeronautics—cont.		
Welding Technology	9/21	Diploma
Aircraft Electrical Engineering	9/21	Diploma
Control Engineering	9/21	Diploma
Flight Control	9	Diploma
Aviation Electronics	9	Diploma
Aircraft Electrical Power Systems	9	Diploma
Guided Missiles	9	Certificate
Automobile Engineering	9/21	Diploma
Aircraft Production	9/21	Diploma
Production Technology	9/21	Diploma
Industrial Engineering	9/21	Diploma
Ergonomics and Systems Design	9/21	Diploma
Borough Polytechnic		
Production Technology	9	Diploma
Power Engineering	9	Diploma
Control Systems Engineering	9	Diploma
Brighton College of Technology		
Highway and Traffic Engineering	9	Diploma
Liverpool College of Technology		
Graduates Industrial Course	3½	—
North Staffordshire College of Technology		
Electrical and Special Ceramics	1	—
Heavy Clay Technology	6	—
Nottingham Regional College of Technology		
Theory and Operation of Semi-Conductors	3	—
Power Systems Calculations	3	—
Power Metering	2½	—
Mechanical Vibrations	1	Endorsement
Portsmouth College of Technology		
Postgraduate Studies in Fuel Technology	6	—
Postgraduate Studies in Mechanical Engineering	6	—
Engineering Technologies for Arts and Science Students	6	—
Special Course for G.E.C.	1	—
Sir John Cass College		
Corrosion	9	M.Sc./Dip.
S.E. Essex College of Technology		
Mechanical Engineering	6	Diploma

Postgraduate Courses for which a particular need has been expressed by Industry

Applied thermodynamics, including sources of data and methods of extrapolation.
Combustion Technology.
Design in electrical generation equipment.
Design in steel manufacturing plant and equipment.
Development of high speed automatic machinery.
High temperature measuring techniques.
Hydraulics.
Hydrodynamics.
Kinematics of linkages and interlocks.
Lubrication and wear processes.
Machine design.
Metallurgy of high temperature sheets.
Microminiaturisation in electronic equipment.
Numerical analysis.
Soil mechanics for civil engineering contractors.
Specialist electronic subjects.
Steel smelting.
Telecommunications: switching principles, storage theory, logic theory, traffic theory, acoustical work, telephone switching techniques.
Thermal fatigue.
Uses of creep data.
Ventilation.

Notes

(*a*) The shortness of the list is undoubtedly due in part to the difficulty of senior officers in companies ascertaining detailed needs without making exhaustive enquiries. It may also indicate a lack of definition about precise training needs.

(*b*) Many of the subjects listed above are already offered in postgraduate courses, but the courses known to the companies concerned do not meet their needs. It is possible that there may be existing acceptable courses not known to the companies.

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DEPARTMENT OF EDUCATION AND SCIENCE

Enquiry into Longer-term Postgraduate Courses for Engineers and Technologists 1964-65

H. ARTHUR
(Group Training Officer, Atomic Energy Authority)

LONDON
HER MAJESTY'S STATIONERY OFFICE
1965

This enquiry was undertaken on the advice of the Committee on Scientific Manpower given in December 1963 and was commissioned by the Office of the Minister for Science.

Synopsis and Summary

This is a report giving the results of an enquiry into longer-term postgraduate courses of an instructional, as distinct from a research, character and concerned with preparing students as engineers and certain defined technologists.

The enquiry was conducted in two distinct parts. Factual information about existing courses of this nature and about the students attending them was obtained from academic institutions by means of a questionnaire. The facts, however, posed questions themselves, and in order to probe the underlying reasons for the existing state of affairs the second part of the enquiry consisted of a round of detailed discussions with representatives of a number of industrial firms and organisations and with a number of senior staff of universities and colleges. The views expressed in these discussions are presented in a consolidated form.

In the presentation of this report pains have been taken to differentiate clearly between factual information and expressed views, and it should be clearly understood that the views given are those arising from discussions with industrial and academic staff and are not personal or official ones.

Main Points Arising from Enquiry

From Statistical Enquiry

(*a*) The bulk of postgraduate courses of the type considered are run by university departments (168 out of a total of 264), and the great majority of these (152) are of an advanced nature as distinct from conversion courses. The majority of courses are organised by departments of chemical, civil, electrical/electronic and mechanical engineering. (Paragraphs 6, 7, 17–20.)

(*b*) The present total of students for session 1964–65 is already greater than for session 1963–64, and when the final number of students attending the shorter courses is known the total for the current session is likely to be substantially greater than for last session. (Paragraph 23.)

(*c*) The average number of students per course is approximately 7 (1,966 students on 264 courses), but 99 courses have 4 or fewer students on them. (Paragraph 24.)

(*d*) A little less than half (45 per cent.) of all postgraduate students are from overseas (731 out of 1,633). (Paragraph 25.)

(*e*) 403 out of the total of 1,633 students (25 per cent.) attending postgraduate courses this session and for whom detailed information is available have first degrees in science and other subjects—mainly in general science, physics and chemistry. (Paragraph 30.)

(*f*) Two-fifths (41 per cent.) of the students from the United Kingdom went straight into a postgraduate course from a first degree course, and almost half of these (47 per cent.) are financed through D.S.I.R. grants. Only 10 per cent. are sponsored by employers, and the majority of these were previously student apprentices or the like with the same employers. (Paragraph 34(i).)

(*g*) Although 32 per cent. of the United Kingdom students who have had a gap of at least a year before taking a postgraduate course are sponsored by their employers, they represent only a total of 169. One-sixth of all students with previous employment experience are receiving no financial aid from any source. (Paragraph 34(ii).)

(*h*) A total of 207 (23 per cent.) of all United Kingdom students taking postgraduate courses are sponsored by their employers. This represents an average of less than one student per course. (Paragraph 34(iii).)

(*i*) Of the overseas students 52 per cent. are without financial assistance from any official source, 29 per cent. are in receipt of some form of scholarship, and 9 per cent. are sponsored by their employers. The number of those sponsored by employers (67) is one-third of the total number of United Kingdom students so sponsored (207). (Paragraphs 35, 36.)

(*j*) The great majority of United Kingdom students express a wish to find employment in research, development or design work, in production work or in continuing at a university to pursue research for a higher degree. A smaller number of students wish to find employment with government departments or consultants or to go into teaching in this country. The only large difference between those who have had no previous employment and those who have is that more of the latter seem interested in teaching and fewer wish to carry on to do research work. (Paragraph 38(i).)

(*k*) Most of the overseas students express a desire either to stay on in this country to do research work for a higher degree or to return to their own country to seek employment. It is doubtful how many of these overseas students will be able, academically or financially, to pursue research work at universities in this country. A number of overseas students are hoping to consolidate their postgraduate studies by having a period of employment in this country. (Paragraph 38(ii).)

(*l*) The great majority of heads of departments report difficulty in interesting employers in their postgraduate courses. D.S.I.R. grants are criticised in number and amount, and lack of staff and accommodation to organise postgraduate courses are mentioned. (Paragraphs 40, 41.)

(*m*) Comparatively few staff from industry, industrial research centres or government departments are used as part-time lecturers on postgraduate courses. (Paragraph 42.)

From Discussions

(*n*) Industry view the use of postgraduate courses from an economic standpoint; the expense and inconvenience of sending a man on a course is measured against the assessed value of the course to the firm. The lack of support for postgraduate courses is a measure of the doubt existing about the value of many courses. (Paragraphs 54, 57, 66.)

(*o*) The real need for production staff is management training, particularly in management techniques. Because of the difficulty of releasing staff from duty, short courses, dealing particularly with the applications of techniques, are required by industry. Industry is prepared to use courses of more than three months exceptionally, but is appreciating that their use must be linked with proper career development plans. (Paragraphs 57–59.)

(*p*) Advanced technological courses are particularly relevant to research, development, technical and design staff, but there are various reasons why industry sends few staff to them:

- (i) There is a tendency for industry to become organised into larger units with their own research and development facilities and for it to feel that training can be given better and more cheaply internally. (Paragraph 62.)
- (ii) There is the feeling that many university courses are too academic and are not sufficiently orientated towards industrial applications and practice. They do not meet industrial needs. (Paragraphs 62, 64, 69, 70.)
- (iii) The problem of release of staff is a very real one and, so long as industry does not carry a margin of staff to accommodate training on a proper basis, shorter courses are required. (Paragraphs 65, 66.)
- (iv) The influence of these courses on industry may well be a long-term one, and their economic assessment, particularly by the smaller firms, is more difficult. (Paragraph 68.)

(*q*) Where academic staff have established close links with industry and research centres, and where industry has taken the initiative to take training problems to the universities, some very successful postgraduate courses have been established. What is needed is closer liaison between the two sides and for postgraduate training to be much more of a co-operative effort. (Paragraph 63.)

(*r*) With the rate of technological change becoming faster there is likely to be an increasing need for periodic refresher courses, and the demand will be for short full-time or part-time courses. (Paragraph 71.)

(*s*) There is a widespread support for a broader based first degree course and for specialisation to be added through postgraduate courses. (Paragraph 71.)

(*t*) A greater flow of industrial staff would go through postgraduate courses if D.S.I.R. awards were made more attractive. (Paragraphs 68, 72, 73.)

(*u*) Effective postgraduate courses need to draw on an active research programme, and it would appear that greater collaboration between industry, industrial research centres and university departments is needed to ensure that this is possible. (Paragraph 74.)

(*v*) Every step towards promoting liaison between industrial and academic staff should be taken. Secondment is one way, but there is little support for the full-time secondment of industrial staff and part-time secondment seems more practicable. (Paragraphs 75–77.)

(*w*) A central clearing office for the dissemination of information about postgraduate courses and for the co-ordination of demands for new courses is suggested. (Paragraphs 78, 79.)

(*x*) There are signs that industry is becoming more conscious of the need for careful staff planning and career development, and this should more clearly define training needs and lead to an increased interest in appropriate postgraduate courses. (Paragraphs 66, 80.)

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